NASA Procedural Requirements

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COMPLIANCE IS MANDATORY

Subject: Aircraft Operations Management Manual

Responsible Office: Aircraft Management Division

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Chapter 5. Unmanned Aircraft Systems Operations

5.1 General

5.1.1 Emerging Concepts. Technological advances will continue to provide unprecedented leaps in UAS capability. NASA is primarily concerned with UAS technology as it applies to aeronautics, space science, and Earth science. Technology that permits the rapid dissemination of remote sensing data products will play an important role in this effort.

5.1.2 UAS Definition. In general, a UAS is a powered or unpowered aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, and can fly autonomously or be piloted remotely. UASs range from micro vehicles measuring inches in size and ounces in weight to large aircraft weighing more than 30,000 pounds. All UASs shall be operated to meet the requirements of this NPR. Appendix I defines the appropriate level of operational control for each category of UAS. [426] For example, a model or small UAS that weighs less than or equal to 55 pounds and whose top speed is less than or equal to 70 knots has fewer oversight requirements than a UAS that weighs more than 300 pounds and whose top speed is greater than 200 knots. Due to the diverse nature of UAS performance and interface, requirements may need to be adjusted to ensure the appropriate level of operational control.

5.1.3 UAS Flightcrew Definition and Responsibilities. The definitions and requirements to be qualified as a NASA UAS pilot or observer are found in Appendix J. Any UAS, operated on behalf of NASA, that operates within the NAS shall be piloted by an individual who is either a NASA pilot or holds an FAA Pilot's License. [427] The UAS flightcrew is responsible for the safe control and operation of the UAS and must be involved in all mission planning; complete prelaunch, mission, and recovery checklists; and assist in evaluating and disseminating in-flight data.

5.1.4 Policy. Center Directors shall establish procedures in accordance with Appendixes I and J to ensure that all UAS flights are properly approved and documented. [428] Center Directors also shall ensure that UAS flightcrews and operations receive direct oversight by the Center's Flight Operations Office or through another Center with a Flight Operations Department. [429] Because UASs are aircraft, other forms of control, specific to aviation, apply to their employment. The most common are air control, airspace control, and air direction, which are exercised by aviation personnel and agencies.

5.1.5 UAS Command and Control Systems. UAS flightcrews must have the capabilities to command, control, coordinate, and manage the UAS. These systems include air control and airspace control as discussed below.

5.1.5.1 Air Control. Air control is the authority to direct the physical maneuvers of a UAS in flight or to direct a UAS to gather data or operate in a specific area.

5.1.5.2 Airspace Control. Airspace control provides for the coordination, integration, and regulation of the use of a defined airspace and identification of all airspace users. Any airborne object that may interfere with the flight path or trajectory of any other object within the NAS airspace is of concern and requires airspace coordination and integration. Airspace control is the authority to direct the maneuvers of a UAS (along with other aircraft and airspace users) for the best use of the airspace. Airspace control is accomplished through established procedures for coordination of airspace by ATC or range authorities. Principles and procedures of airspace control used in manned flight operations apply to UAS operations. UASs capable of long-distance flight are normally routed through existing air control points by airspace control agencies. Airspace control authority is inherent in the operator whose unit is responsible for particular blocks of airspace; positive separation between aircraft and UASs is required and is the responsibility of the PIC and airspace control agency. This may be accomplished by the following:

a. Activating temporary airspace coordination areas (ACAs); Class D airspace or restricted operations zones (ROZs) for UAS takeoffs and landings; and mission areas or flight routes. ROZs are also known as restricted operations areas (ROAs).

b. Routing separation via existing air control points. Specific UAS routes may be created by connecting selected air control points.

c. Altitude separation, which can be effected by having block altitudes or by deconflicting the altitude at which the UAS is flying with other airspace users.

d. Time separation, which can be effected by having block times for UAS operations.

e. Any combination of the above, as required.

5.2 Planning

5.2.1 Operating Within the Continental United States (CONUS). Before any deployment, considerable planning takes place well in advance of a UAS operation. UASs increase the workload on personnel assigned, who very often know little about the unique requirements of UAS integration in operations in CONUS or overseas. Coordination with appropriate agencies or countries should occur as soon as the decision is made to employ a UAS.

5.2.1.1 Certificate of Authorization. The FAA is responsible for airspace management within the CONUS. If a UAS will be flown outside the boundaries of special-use airspace, sufficient time must be allowed to authorize UAS operations. The FAA Administrator will draft a certificate of authorization, which sets forth the requirements for UAS personnel qualifications, communications procedures, and a definition of the requested airspace. A UAS cannot fly beyond the boundaries of special-use airspace without specific authorization of the FAA.

5.2.1.2 Memorandum of Understanding. A memorandum of understanding with the local air traffic control facility is required to ensure that they and the UAS flightcrews have a complete understanding and agree upon the air traffic control procedures that will be used to ensure safe UAS operations in the operating area. If additional air traffic control services are required, the UAS operator may be asked to augment the local air traffic control facility with additional air traffic control personnel.

5.2.1.3 Letter of Agreement. A letter of agreement with local air facilities shall be completed to ensure that proper coordination of support requirements is understood and agreed upon. [430] Fuel and hazardous material storage, hangar facilities, runway use, or any other logistical and support requirements must be agreed on in this document.

5.2.2 Deployment Overseas. Foreign governments are sensitive to the valuable information that could be collected and capabilities of UASs, as well as to the inherent risks associated with unmanned flight operations. As NASA aircraft, NASA UASs have state aircraft status. UAS planners must ensure that UAS operations are included at the outset of integration planning within host nation (HN) airspace. Planners must have a firm understanding of the UAS to be employed so that they can satisfy any protests or concerns from the HN. The UAS planner shall work via the Office of International and Interagency Relations to gain diplomatic clearances prior to any UAS operations within their represented country. [431]

5.3 Preflight Operations

5.3.1 Operations Site. Particular consideration must be given to the location of the UAS operations site. Depending on the UAS, an adequate runway may be required for safe UAS operations. At a minimum, a proper landing surface must be available to safely recover the UAS upon completing its mission. Consideration also must be given to the distance from the UAS operations site to the area of operations (AO). Many UASs are not particularly fast and require considerable time to fly to their mission area. The location of an adequate launch and recovery area and its distance to the AO and control station are very important considerations when employing a UAS. Availability of adequate roads or other transportation methods for resupply of fuel and other UAS support requirements are critical to sustained UAS operations. If the UAS is expected to move from one site to another, transportation support becomes increasingly important.

5.3.2 Weather. UAS managers must consider the expected weather conditions in the AO at the time of operations. Many UASs cannot operate in inclement weather (e.g., high winds and precipitation or when the cloud layer is below the UAS's operating altitude).

From the outset, due consideration must be given to probable weather conditions.

5.3.3 Communication. To provide UASs with adequate support, the command and control architecture must be linked to the UAS. Most UASs have a ground control station (GCS), a tracking and control unit, a portable control station (PCS), and remote receiving stations. The UAS is manually controlled by a pilot from a control station or is programmed to fly independently under control of its autopilot. More than one control station may be used to increase the UAS's effective range or to control more than one UAS.

5.3.4 Operational Phase. UAS operations are conducted similarly to manned aviation operations. Once the UAS has authority to conduct the mission, many tasks are executed simultaneously. The operations phase begins the planning process. The program managers and the UAS flightcrew study the assigned mission and plan for its operation. The maintenance crew begins preparation of the UAS and the UAS ground control system, while communications personnel ensure that the proper communication connectivity is provided to fulfill the mission.

5.3.5 Route Planning. UAS missions will be planned by the UAS planners in close coordination with the Center's Flight Operations Office. This is done to ensure there is no conflict with other flight operations and to allow timely inclusion of UAS missions in the Center's planning process. Flight planning for routes that afford little or no time to avert the response to an erroneous data entry that could lead to a significant mishap (Class C or higher) shall have an independent review both before loading in the mission computer and after upload on the UAS is complete. [432]

5.3.6 In-flight Emergencies. During planning, sufficient attention must be given to the possibility that an in-flight emergency may occur. Particular attention should be given to the location of emergency landing sites if the UAS exits controlled flight and impacts the ground. Flight paths, minimum-risk routes, and other air management tools must be included.

5.3.6.1 Loss of Link Procedures. When a UAS senses a significant delay or loss of the command uplink, the predetermined loss-of-link procedures will be invoked to place the UAS on the returns home profile, or a suitable alternate route and recovery location. The UAS return home or alternate profile is a preapproved route (at a preapproved altitude) to its preapproved return home or alternate site. During this emergency, the UAS pilot will attempt to reestablish communication with the UAS.

5.3.6.2 Agency Notification. Upon notification of an in-flight emergency, emergency procedures shall be performed by the UAS pilot in accordance with the Center procedures, flight authorizations, and the UAS operations manual. [433] The Center's Flight Operations Office will then relay and coordinate with the appropriate agencies (e.g., FAA, ATC). The Center's Flight Operations Office will ensure that air control agencies have been notified of the UAS emergency and its expected course. Controlling agencies will ensure that other air assets are separated from the UAS's expected route of flight and notify the Center's Flight Operations Office of any further actions taken.

5.4 Flight Operations

5.4.1 Flight Brief. A flight brief that includes the flightcrew, a program representative, and a maintenance representative shall be conducted prior to all flights. Briefs provide specific information in accordance with UAS standard operating procedures. Briefs will include the following:

a. Weather update.

b. Program brief.

c. System update.

d. Emergency divert airfields.

e. Emergency procedures and terminology.

f. Mission profile. [434]

5.4.2 Takeoff Method. The maintenance crew readies the UAS for launch as the flightcrew performs systems checks to ensure that systems perform in accordance with operating procedures. Systems checks shall include an independent means to verify waypoints entered into a navigational system prior to takeoff. [435]

5.4.2.1 If a suitable runway is available, the UAS operator may perform a conventional rolling takeoff. The length of runway required depends on the UAS. If a suitable runway is not available, then an alternate launch method shall be used. [436] An adequate surface area must be available for a safe landing for the UAS and safe mobility of nearby personnel.

5.4.3 Preparing for Recovery. Upon return to the UAS operations site, flight and maintenance crews prepare for UAS recovery. The UAS recovery checklist shall be adhered to in accordance with the operations manual. [437]

5.5 Flight Crew Requirements

5.5.1 Qualifications. UAS flightcrew members shall become qualified in accordance with written Center standards in accordance with Appendix J. [438] The Center's Chief of Flight Operations, with the concurrence of the Center Director, shall designate UAS pilots for the specific type of UAS they operate. [439] The Center's Chief of Flight Operations shall ensure that each UAS flightcrew possesses an adequate level of training and experience to perform the duties of the designated positions as laid out in Appendix J. [440] Overall qualifications for the designations are made based on flightcrew's overall flight experience, experience in similar types of UAS aircraft, experience in the actual UAS aircraft type, other training, and demonstrated performance. Designated UAS pilots are those who perform UAS piloting duties, as a part of their official position descriptions, to fulfill NASA contract requirements, or in accordance with an interagency agreement.

5.5.2 Training. Depending on the category of the UAS pilot, per Appendix J, qualification training may be conducted under the direction of a military, civilian, or NASA UAS instructor pilot.

5.5.2.1 Qualification training will vary with the UAS pilot type, as listed in Appendix J, but will normally include:

a. Ground training (including UAS ground control station checkout), handbook study, attendance at formal UAS aircraft training programs, emergency procedure training, and the performance of a UAS aircraft written examination (open book).

b. Simulator training, if available, including normal and emergency procedure training.

c. UAS aircraft checkout flights, including a prescribed number of UAS flights and landings (if applicable) under the supervision of a UAS instructor pilot.

d. A mission profile flight monitored by a UAS instructor pilot to obtain full UAS mission qualification.

e. Per Appendix J, remote pilots shall meet the minimum qualifications for a NASA pilot based on this NPR and Center-established processes and procedures. [441]

f. Fully qualified NASA pilots may be assigned as UAS pilots, but for UAS pilots to fly manned NASA aircraft, they shall meet NASA pilot qualification minimums. [442]

5.5.2.2 Initial UAS training shall be documented by each Center in accordance with Appendix J, with the approval of the Center's Chief of Flight Operations. [443] The training program will be tailored to consider previous experience in UAS aircraft, currency in similar types of UAS aircraft, previous training background, and availability of other resources to ensure an adequate level of training.

5.5.2.3 In the case of prototype, experimental, or research UAS aircraft for which no formal schools are available, the services of the designers and the manufacturer's best qualified personnel shall be utilized to brief and familiarize the UAS pilots with the aircraft, UAS aircraft systems, and ground control stations. In addition, existing UAS simulators and UAS aircraft of a similar nature will be used to train pilots prior to flying a UAS research vehicle. [444]

5.5.2.4 Training for all members of the UAS flightcrew shall include crew resource management training. [445]

5.5.3 Currency. Currency is dependent on the category of UAS pilot. In accordance with Appendix J, Center Directors have the authority to establish and approve UAS flight currency requirements. Remote pilot requirements are detailed in Chapter 12 and Appendix J. These include specific requirements established for particular UAS flight research programs and UAS aircraft. Records of qualification and flight evaluation are required. NASA UAS flight time shall be kept separate from NASA manned aircraft flight time, by type, in NAMIS. [446] A review of UAS pilot and crew qualifications shall be made prior to flight assignment to ensure that prerequisites for the intended mission are met. [447] The Center's Chief of Flight Operations shall designate the crewmembers for UASs that are under the Center's purview. [448]

5.6 Airworthiness and Flight Safety Reviews

5.6.1 General. The airworthiness requirements detailed in Chapter 2 must be used for UAS airworthiness approvals. Additionally, all UAS flight operations under NASA's purview are subject to the requirements of NPR 8715.5, Range Safety Program.

5.6.2 Airworthiness and Flight Safety Review Board. The Airworthiness and Flight Safety Review Board (AFSRB) shall participate in or, at their option, conduct reviews to establish the airworthiness and evaluate the safety of flight operations. [ ] The chair and members are designated by the Center Director as discussed in Chapter 2.5. Other personnel who shall participate in the review include the Safety, Reliability, and Quality Assurance Office, the mission manager and/or Principal Investigator, the UAS operator, and Range Safety personnel. [450]

5.6.2.1 The following additional topics shall be addressed by a NASA AFSRB to assess the risks associated with a UAS flight program:

a. General outline of major UASs.

b. Communication links and frequency management plan.

c. Flight control system and configuration control procedures.

d. Backup systems and procedures.

e. Flight terminations systems, including ground abort. [451]

5.6.3 Public Safety. The program/project manager shall limit the assessed collective risk associated with aerospace vehicle operation and ensure that the probability of doing harm to a member of the general public is not greater than the criteria established by NPR 8715.5. [452] The ability to achieve this level of protection can be demonstrated through a combination of analysis, tests, simulations, use of redundancy in design, and flight operational procedures.

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